RUDOLPH KOENIG.

THERE has passed away in the person of Dr. Rudolph Koenig one whose name will be remembered in the science of physics, and who filled a unique place. To the outer world he was known simply as a maker of tuning-forks. To the inner circle of science he was known as the author of original researches in a line peculiarly his own. To the few who had the privilege of an intimate acquaintance he was known as a simple-hearted, whole-souled devotee of his chosen science of acoustics: one who lived for and loved his work.

Born at Königsberg in 1833 of a family connected with the University, he was himself trained in the Philosophical Faculty of that famous centre. He graduated as Doctor of Philosophy, and well might have looked forward to a successful career as professor of physics in one of the Universities of his native land. What cross-currents of destiny drove him far afield are not clearly known to the present writer. But the year 1860 saw him established in Paris as a constructor of acoustical instruments, carrying out the traditions of fine workmanship established by Cavaillé-Coll. He had an *atélier* in the Place du Lycée Louis le Grand, and here he worked out a number of new acoustical instruments. The phonograph, or phonautograph as it was later called, of M. Scott de Martinville for recording the vibrations of tones and words was brought to Koenig to be put into shape. Accounts of this instrument will be found in *Cosmos*, vol. xiv, in the *Athenaeum* of 1859, and in the Report of the British Association for the same year. It was Koenig's part to devise a better mouthpiece and a more sensitive membrane. He also devised the recording drum, driven on an axis cut with a screw thread. I once asked him whether, when he was working with M. Scott on this instrument, it had not occurred to either of them that the record of the vibrations might not be used over again to reproduce the sound, as discovered nearly twenty years afterwards by Edison. His reply was: "No, the idea never occurred to either of us; we never thought of anything except recording." He constructed series of standard tuning-forks furnished with recording styluses; he improved the mechanical construction of the Seebeck siren; he studied the vibrations of plates and of columns of air. In 1862 he brought over to London to the second of the series of International Exhibitions a fine set of his new apparatus, including an acoustical album or collection of graphic tracings recording the composition of vibrations; and for the exhibit he was awarded a gold medal. About the same time began the publication of his experimental researches in acoustics which lasted nearly forty years. The earliest of these to be noted was the invention of the manometric flame. Organ pipes fitted with manometric capsules for investigating the vibrations of the air column by means of gas-flames were shown in the London Exhibition of 1862, and they were described by him in vol. cxxii. of Poggendorff's *Annalen*, pp. 242 and 246, of the same year. He constructed resonators for Helmholtz (see Appendix I. of the first edition of the "Tonempfindungen," 1863); he repeated the experiments of Philipp Reis with the primitive telephone of that neglected inventor; he devised a new stethoscope furnished with one or more flexible rubber tubes to admit of simultaneous auscultation by several observers. In the *Comptes rendus* of March 1864 he had a memoir upon the vibration of plates, in which he discussed the sound-figures in sand discovered by Chladni and the explanation of their formation then recently suggested by Wheatstone. In 1870 he had another article in the *Comptes rendus*, on the fixed notes which are characteristic of the different vowels. In 1872 came a second memoir on manometric flames in the *Annalen*.

During these ten years Koenig had been attempting to build up the business of manufacturer of acoustical instruments. His standard tuning-forks were sought after by physical investigators. The impulse given to acoustical subjects by the publication of the famous book of Helmholtz was undoubtedly great; and the researches of Chladni, Wertheim, Melde, Terquem, Wheatstone and Mach were claiming great attention. Koenig adopted the suggestion, urged by Chladni in 1830, of fixing as the normal scientific pitch for his standards that in which middle C of the keyboard is assigned to 256 complete vibrations per second. In the "Catalogue of Acoustical Apparatus" which Koenig published in 1865—itself an evidence of his scientific and industrial activities—he notified his adherence to this standard for the *diapason normal*. He had now moved into the Rue Hautefeuille on the south side of the Seine, where he lived and worked until about 1878, when the house was demolished in the construction of the Boulevard St. Germain through the Quartier Latin. Unhappily the outbreak of the Franco-Prussian War rendered it difficult for a German to live in Paris. Of a retiring and sensitive disposition, he found himself somewhat isolated in his work. The scientific world was rather cold toward the man who made a living out of selling tuning-forks. Other instrument makers began to copy his instruments, and were able, not having the same scientific ideals, to undersell his manufactures by producing less carefully-made articles. Koenig never swerved one hair's breadth to meet this competition. He knew the quality of the work that left his little factory. Not one tuning-fork, during these more than thirty years, left the place without having been personally adjusted and verified by him. No single instrument of second quality ever bore his mark. The monogram "R. K." stamped upon his work became an absolute guarantee of first-rate workmanship. Others might cheapen their manufacture by neglect of quality: he would maintain the quality of his *coute que coute*. If by some stroke of luck he sold instruments that brought in a few hundred francs above the regular income of his business he would hail it as the means of constructing some new piece of experimental apparatus that might never find a sale, but would help his investigations. And so with a slender business and a few faithful workmen at his back he maintained a proud independence, sufficient to enable him to continue research.

In 1876 he went over to America and took with him to the Centennial Exposition at Philadelphia a splendid series of his beautiful instruments in the hope of doing advantageous business. The Jury's report of the awards in Group xxv. speaks in glowing terms of this effort. "In the present Exhibition," it runs, "Dr. Koenig has presented a collection of instruments of demonstration and investigation constructed on a scale of magnitude heretofore unattempted, and exhibiting with surprising power the effects of interfering undulations. He also presents a tonometric apparatus, consisting of about 670 diapasons or tuning forks, giving as many different shades of pitch, extending over four complete octaves, and making equal intervals of eight simple vibrations each for the first octave, and of twelve each for the succeeding octaves; the whole forming an absolutely perfect means of testing, by count of beats, the number of vibrations producing any given musical sound, and of accurately tuning any musical instrument. In addition to these more conspicuous portions of his display, Dr. Koenig exhibits the various forms of apparatus of demonstration for which he is so well known, all of which are marked by the accuracy of indications and excellence of workmanship which have given him his deserved reputation as a constructor." . . . "Of the exhibit of Dr. Koenig, as a whole, it may be said that there is no other in the present International Exhibition which surpasses it in scientific interest." The interest excited by this exhibit was so great that an appeal was circulated, signed by Joseph Henry and others, suggesting the purchase of the instruments. Koenig was induced to leave them at the University of Pennsylvania under promise of their being insured for 10,500 dollars and of a weekly account of the subscription being sent to him. But after a long and vain expectation of the weekly accounts, and the writing of many unanswered letters, it became evident to Koenig that things were going wrong. In June 1878 Mr. Munzinger, who had undertaken to collect the funds, announced to Koenig that he had remitted the whole subscription to Prof. Barker, but on December 15, 1879, Prof. Barker wrote: "Mr. M. has not yet turned over to me the subscription for the acoustical collection." On June 30, 1882, he again wrote: "With regard to your collection, I have been entirely unable to complete the subscription for its purchase." There remained nothing for Dr. Koenig to do but to go over and remove the collection. A portion of it was sold at some sacrifice to the University of Toronto, the physical collection of which it adorns; while the rest was brought back to Paris. The incident had the most unfortunate effect on Dr. Koenig. It crippled his slender resources for more than ten years, and it tended to sour his sensitive temperament. He had in 1876 communicated to Poggendorff's *Annalen* two papers, one on a tuning-fork of variable pitch, the other upon the phenomena produced by the interference of two tones. This latter paper is one of the undoubted classics of science. Using the most splendid and perfect of all tone-producers, the substantial steel tuning-forks of his own design, he had for years been investigating the phenomena of beats and the production of interference-tones. Applying the phenomena of beats every day in his workshop for the purpose of adjusting forks to their exact pitch, he acquired a familiarity with the phenomena such as no other experimenter could possibly attain. His published research is a model of careful and accurate observation. Helmholtz had given the well-known theory that when two tones are sounded together there are produced two other tones, known as the difference-tone and the summation-tone, having frequencies respectively corresponding to the difference and the sum of the frequencies of the two fundamental tones. Koenig, finding himself unable to confirm the existence of these alleged tones, set to work to find out what the actual facts were. He investigated both the beats and the resultant tones. He found that primary beats were not all of one kind; that they could be ranged in two sets, an inferior and a superior set. Of these the inferior alone correspond to the difference of the frequencies, and so correspond only in the first octave. Outside the first octave neither set of beats corresponds either to difference or to sum. He found that when with higher forks resultant tones are produced they likewise may be ranged in two sets, an inferior and a superior set, the pitch of these resultant tones being always precisely that calculated as for beats. These resultant tones are never either summation-tones or difference tones except for tones within the range of the lower half of the first octave of relative pitch, within which limits alone they correspond to the difference of the frequencies. Outside that limit there are no difference-tones. Under no circumstance, when pure notes are used as the two fundamentals is the alleged summation-tone heard. It is true that Prof. Rücker has by the most refined optical appliances demonstrated the objective existence of the summation-tone. But the source was a powerful siren which notoriously generates an impure tone. Koenig's statement of 1882, "Je ne connais jusqu'à present aucune expérience par laquelle on pourrait prouver avec quelque certitude l'existence de sons différentiels et de sons d'addition," remains absolutely true to-day. During the years that followed the unhappy incident of 1876 Koenig continued his investigations. Amongst the apparatus at Philadelphia was the first of his wave-sirens, a novel instrument which for the first time enabled the experimenter to build up synthetically a complex tone out of harmonic constituents in such a way as to vary at pleasure the phases of the component tones. He had discovered that, contrary to the theory of Helmholtz, phase-difference does exercise a modifying effect upon the timbre, and is physiologically observable. This theme he developed in a memoir entitled "Bemerkungen über die Klangfarbe," which was published in *Wiedemann's Annalen*, vol. xiv., in 1881. For this research he constructed a large new wave-siren on a different plan. The same instrument enabled him to investigate the properties of tones produced by a succession of irregular waves. In 1882 he published, under the title of "Quelques Expériences d'Acoustique," a volume of 243 pages resuming his experimental researches down to that date. This volume is now very scarce: it is a veritable treasury of careful and refined experimental investigation. Of these acoustical researches a summary was given by the present writer in NATURE some years ago. In 1890 Dr. Koenig brought over to London his large wave-siren and a number of the larger tuning-forks, and himself demonstrated the principal points of his researches before a meeting of the Physical Society. These instruments were also shown at the Royal Institution in June of the same year at a Friday evening discourse on the physical basis of music. A few of the forks were acquired for the National Collection at South Kensington.

On recovering in the autumn of 1882 the unsold portion of his acoustical collection, he proceeded to reconstruct, on a larger scale than before, the great tonometer, the series of standard tuning-forks which originally extended in unbroken series only from the frequency of 128 to that of 4096 vibrations. He added massive steel forks, some of them weighing nearly 200 pounds, taking the frequency down to 16, while at the higher end of the scale he added several octaves, so that eventually he reached a pitch above the superior limits of ordinary audition. One of his latest researches was, indeed, upon the verification by the method of Kundt of the wave-length of these inaudible forks, going up to 45,000 vibrations per second. This splendid set of standard instruments has remained until now in Dr. Koenig's *atélier*. An attempt was made about three years ago—unfortunately without success—to secure it for the National Collection of Scientific Apparatus at Kensington. It can never be duplicated, and its dispersal would be a misfortune for science.

Dr. Koenig suffered during his last years from much broken health. He never married, but lived alone, surrounded by the instruments of his creation, in his workshop on the Quai d'Anjou. Here he received from time to time the visits of his friends. The late Mr. Spottiswoode used frequently when passing through Paris to visit him. A brief word of announcement that one would give oneself the pleasure of calling next Sunday morning always found Koenig ready and pleased to spend an hour in showing his latest experiments. The last time that I had this opportunity was during the Electrical Congress in September 1900. He had during the preceding week had a similar visit from Lord Kelvin. Koenig was even then very ill. He suffered terribly in body and was obviously feeble. For some months he had lived on nothing but milk. But he was as animated and keen as ever. He had some new observations and a new instrument—no account of which has been published—demonstrating the influence of phase upon the quality of compound tones. They were simple and convincing. But the occasion was mournful; his bodily sufferings were only too evident. He wrote me in the spring of the present year that his health was still more precarious. He died on October 2, 1901, aged sixty-eight years.

Dr. Koenig was an honorary fellow of the Physical Society of London. He had received few tokens of recognition from academies or learned societies; and this one, conferred only last February, gave him evident pleasure. But his work, so courageously maintained in the true spirit of scientific devotion, will remain as his monument to all time. S. P. T.

THE McCLEAN TELESCOPE AT THE CAPE OBSERVATORY.

WE have on many occasions recorded munificent gifts towards scientific research and education from wealthy Americans and others, and now and again it has been our pleasurable duty to call attention to instances of similar generosity on the part of our own countrymen. Naturally it is more gratifying for us to record the latter than the former, especially, perhaps, as the occasions are less frequent. The weekly edition of the *Cape Argus* for October 2 instances a notable example of such a gift in its account of the ceremony which took place recently of the unveiling, by his Excellency the Governor (Sir W. Hely-Hutchinson), of the inscription stone of the magnificent telescope which Dr. Frank McClean, F.R.S., has presented to the Royal Observatory at the Cape. This telescope was offered and accepted some years ago, but many delays have occurred.

Says our contemporary: "The pleasant little ceremony . . . deserves more than passing mention. It gives an opportunity for the cultivation of a virtue which is not too common at the Cape—the virtue of gratitude which Shakespeare knew as a 'noble thankfulness.' And if for the nonce the public should be led to depart from its usual Philistine attitude towards pure science and the higher walks of research, the change may not be ungraceful, and may do it good. The value of Mr. McClean's gift it would be hard to overestimate. In mere money's worth it was princely—more than the Imperial Government could well spare, and more than the Colonial Government could venture to dream of as an encouragement to unapplied science. It was given, too, at the right time and to the right place, there being immediate need for a wide development of spectroscopic work, and the southern hemisphere being poorly supplied with astronomical equipment compared with the affluent north. Further, it did not come from a mere millionaire, willing to be moderately fleeced in return for a little notoriety; Mr. McClean was a skilled and assiduous worker in this branch of science, and what he gave was the outcome of a pure heart and a noble enthusiasm. Nor did he stop at the purely material gift, but gave time and thought and trouble to make sure that the telescope and its accompaniments should be fit for the performance of the very best type of work. He came to the Cape and resided for months here, and those who were privileged to meet him will always remember his unassuming ways and his unflagging interest in his work. He had a double purpose in coming, and by far the greater portion of his time was spent in obtaining the spectra of certain southern stars, in order to supplement his similar work in the north. When this was done, the kindly English gentleman left as quietly as he came. The scientific equipment of the Colony had been handsomely enriched by him, but so far as the general public was concerned he left 'unhonoured and unsung.' . . . The need of scientific and literary endowments at the Cape is well known, and the forgetfulness of those whom the land has made wealthy is occasionally bewailed: it would ill become us, therefore, to be equally forgetful of the far-seeing liberality of a stranger who owed us nothing."

The proceedings were opened, in the presence of a distinguished company, by Sir David Gill, K.C.B., F.R.S., His Majesty's Astronomer at the Cape, who delivered an address, space for which we regret to be unable to spare, after which Sir W. Hely-Hutchinson, in the course of a brief speech, said that in regard to the magnificent gift which Mr. McClean had made to the Observatory, he ought to say that it was the desire of H.R.H. the Duke of Cornwall and York to have performed the ceremony which he (the Governor) was now inadequately to undertake. The fact that the telescope had been named the "Victoria Telescope" was, doubtless, one reason which had actuated His Royal Highness in this regard, but the fact that so handsome—he might say, so princely—a gift had been made to science deserved the full recognition of the highest in the land. His Royal Highness not having been able, however, to unveil the inscription stone, owing to the great number of engagements which were pressed upon him during his recent visit, it had fallen to his (the Governor's) part to do so.

The whole company then proceeded to the outside of the building, where his Excellency removed the Union Jack which covered the inscription stone. The inscription was simply as follows:

1897: The Victoria Telescope.
The Gift of Frank McClean,
of Rusthall, Kent.
David Gill, H.M. Astronomer.

While assembled round the stone cheers were given, first for the donor of the telescope and then for the Governor, and the proceedings terminated.

THE NERNST LAMP IN AMERICA.

THE paper read last August by Mr. A. J. Wurts at the annual convention of the American Institute of Electrical Engineers on the development of the Nernst lamp in America is especially interesting as being practically the first to contain any full description of the physical characteristics of the Nernst filament, or "glower" as it is generally called to distinguish it from the carbon filaments of incandescent lamps. It is interesting, too, in that it affords evidence that the lamp is eventually emerging from the laboratory stage and becoming a really trustworthy commercial article. It will be remembered that shortly after Nernst's invention was made public the commercial development of the lamp was taken up by four companies—by the Allgemeine Elektricitäts Gesellschaft in Germany, by the Westinghouse Company in America, by the Nernst Electric Light in England and by Ganz and Co. in Austria. The German company, who possess the patent rights for most of Europe, including England, have for some time had the lamp on the market in Germany, and, as their exhibit at the Glasgow Exhibition shows, are now introducing it into this country. The Westinghouse Company have also, to judge by the paper by Mr. Wurts, developed the lamp to a degree justifying its introduction into commercial use in America. Three or four years may seem to some a long time to have spent on the improvement of Nernst's invention before it could be considered practically available, but when the great complexity of the lamp as compared with an ordinary incandescent lamp is taken into account it cannot be regarded as excessive.

We propose to consider briefly some of the electrical properties of the glower as described by Mr. Wurts rather than to give a detailed account of the mechanical construction of the lamp. Those who take an interest in this side of the subject may be referred to the *Electrical Review* of New York for August 31 and September 7, in which will be found a full reprint of the paper and a short summary of the discussion which it raised. The